OPPORTUNITIES FOR AGRICULTURAL ENGINEERING RESEARCH IN THE SOUTHEASTERN STATES*

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The southeastern states of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, and Kentucky as a group produce practically every crop grown in the southern United States, including cotton, corn, potatoes, hay, tobacco, rice and other small grains, sugarcane, truck crops, and small and large fruits, especially citrus. Dairying and animal and poultry production are also quite general throughout the region. While they are usually incidental to crop production, in some sections they are fairly stable and basic industries and possibly will become more so under the impetus of the southern livestock program being formulated by the U. S. Department of Agriculture.

Some fairly large farms are found particularly in the major cotton-growing sections, but the region as a whole appears to be essentially the home of the medium and small sized farm. Also in areas such as the cotton and citrus belts the agriculture frequently is devoted to one specialty in large, medium, and small sized units, although the tendency for diversification is growing.

For practical purposes the programs of research in progress at the agricultural experiment stations in the states concerned may be considered to indicate the important problems confronting the agriculture of the region. During the fiscal year ended June 30, 1930, they totaled somewhat over a thousand projects. However, less than 2 per cent of these projects could be classed as agricultural engineering, and they represented an expenditure of only about 1 per cent of the total amount expended for agricultural research in the region during the year. For the United States as a whole, on the other hand, the percentage of agricultural engineering research at the experiment stations approximated 4.5 per cent in number of projects, and 4 per cent in expenditure of funds. This included several arid or semiarid states and industrial states which are not primarily agricultural. The Southeast being primarily an agricultural section therefore appears to be far below the average in the development of agricultural engineering in the solution of agricultural problems.

A first-hand observation during the past year of the programs of research at the agricultural experiment stations in the southeastern states has revealed numerous instances in which it would appear that engineering could participate to advantage. Attention is therefore drawn to the general nature of a few outstanding instances of this character.

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CROP PRODUCTION

The production of field, truck, and fruit crops is preponderantly the most important feature of the agriculture of the Southeast. This is suggested by the fact that practically 80 per cent of the research at the agricultural experiment stations of the region is centered on problems of crop production, including soil preparation, cultivation, and fertilization, planting, growing, harvesting, breeding, storage, and marketing of crops, and combating crop diseases and insect pests. The predominance of small and medium scale farming in the region suggests also that much of the field and forage crop production, with the exception of cotton, is primarily for the home support of small livestock enterprises.

Cotton.--Of the field crops grown in the region, cotton is the most widespread and generally important money crop, and is more or less typical of the field crops in its general cultural requirements. An examination of the research programs relating to cotton reveals problems of tillage, planting, fertilization, cultivation, dusting for insect control, harvesting, ginning, seed processing, and storage, in which it would appear that the engineer may be of valuable assistance.

Seed bed preparation, including plowing, harrowing, and the like, consumes a relatively large proportion of the total power required in the production of a cotton crop, and is therefore an expensive feature. It seems important, therefore, that the agricultural engineers study the cotton soils of the region in cooperation with the soils technologists and the agronomists with the idea of developing tillage methods and tools which will adequately produce the degrees of tilth required for the best germination and growth of cotton in the different soils with a minimum cost for labor and power.

The so-called soil dynamics research at the Alabama Experiment Station, which is elucidating the fundamental principles of tillage in different soils to provide a rational basis for tillage implement design, is a striking example of this kind of agricultural engineering investigation. Its practical end point is reflected in the ability of that station to state with confidence, for example, that the cylinder disk plow is satisfactory for the tillage of sandy or loam soil, but is not well adapted to Black Belt soils. Thus a knowledge of the fundamental principles of soil dynamics and the mechanics of tillage is essential, not only to the proper development of tillage methods and equipment to meet the tillage requirements of cotton and other crops, but to the intelligent judgment of the merits of available tillage methods and machines with reference to their economical and efficient adaptation to different types of farming and sizes of farming units.

The planting of cotton so as to insure a satisfactory stand offers a peculiarly important and difficult problem for engineering solution in many parts of the Southeast. In some sections the soil and climatic conditions in the spring are such that cottonseed must germinate under a hard soil crust, and the young plant must force its way upward through the crust. The situation is especially difficult under conditions of wilt or other diseases and the securing of a stand becomes an uncertainty.

Studies of the causes of formation of crusts in certain of these soils after rainfall have been started at the Alabama and Mississippi Experiment Stations, for example, with the idea of developing methods of treatment and tillage to prevent their formation so far as possible. Assuming the inevitable formation of crusts under certain conditions, other studies are being made of the breaking strength of typical soil crusts and of the vertical pressure which the individual growing cotton plant is able to exert against them. These studies are aimed at the development of proper planting methods with reference to number of seeds required per hill or per unit area of soil surface, depth of planting, and the like. With this basic information the necessary planting methods and machinery are being gradually developed with some assurance that they will render satisfactory results. In the Middle South, the Arkansas Experiment Station has reported considerable progress in the development of hill planting of cotton under similar conditions.

Fertilization is offering an important problem needing engineering attention, especially since the advent of some of the new concentrated fertilizers. A national committee, consisting of several experiment stations, the National Fertilizer Association, the American Society of Agricultural Engineers, the U. S. Department of Agriculture, and other agencies, has been working on this problem for several years. Owing to the cost of fertilizers and the expense of placement in power and labor, it is important that fertilization practices be so developed as to secure maximum utility and minimum injury of the fertilizer to the crop at minimum expenditures of power and labor for placement.

Obviously this calls for cooperation with the agronomist and soils specialist to establish the rates of application and time and manner of placement of fertilizers required by the cotton crop in different soils. The engineering problem is to develop fertilization methods and machinery which will meet these basic requirements using different types of fertilizer. The problem seems so important throughout the cotton-growing regions as to command rather widespread engineering attention, and progress already has been reported by some stations.

Cotton cultivation, like seed bed preparation, consumes considerable power and is one of the expensive items of cotton production. The Mississippi and Alabama Experiment Stations of the Southeast and the Arkansas Experiment Station of the Middle South already are showing how, by proper planting and row spacing and by the use of proper machinery, the cost of cultivation of cotton can be appreciably reduced. The Arkansas station especially has developed hill planting, cross harrowing, and checkered cultivation to a point where hoeing and hand-thinning are practically eliminated. The Alabama station also has demonstrated the utility of the pipe gang, large wheel, pivot axle cultivator for work on bedded or furrow crops in certain localities. In every instance, however, cooperation with the agronomist and soils specialist seems advisable to establish the cultivation requirements of the crop in different soils as a basis for the development of adequate cultivation methods and machinery.

The control of the insect pests of cotton, such as the boll weevil, pink bollworm, cotton hopper, red spider, and others, is a problem confronting entomologists throughout the Southeast. From the economic standpoint, the use of dusts for control seems imperative. The entomological studies are indicating the time and manner of dusting which is most destructive to the different insects. This offers an interesting and worth while opportunity for engineers to cooperate by undertaking the development of methods and machinery which will properly project and deposit the dusts where they will do the most good. A study of the physics of dust movement in air under pressure would seem to be an important preliminary to such work.

The harvesting of cotton so far is largely a hand operation and is one of the big expense items in cotton production owing to the excessive amount of labor required. It is of paramount importance to lower the cost of production in every possible respect so long as the quality of the product is not impaired. Several beginnings have been made in the development of mechanical cotton harvesters, notably by the Texas Experiment Station, and progress gradually is being made in their further improvement. The whole matter of cotton harvesting therefore offers the agricultural engineers in the southeastern states a most interesting and worth while opportunity for constructive research along definite cost-saving lines in cooperation with the cotton specialists.

The ginning of cotton appears to have never been placed upon a fully satisfactory basis. The Mississippi Experiment Station recently entered into an investigation of cotton ginning methods and machinery with the idea of introducing greater efficiency and economy into the process. This has called for laboratory studies of the different mechanical features of the ginning process under controlled conditions of temperature and humidity to learn the requirements for producing properly ginned cotton as bases for the further development and improvement of the process and equipment. Such work obviously calls for cooperation with cotton specialists and offers numerous worth while opportunities for engineering participation.

Corn and other field crops.--Corn probably follows cotton closely as a generally important field crop in the Southeast, being utilized largely for home consumption by livestock. Its economical production offers the agricultural engineer problems of tillage, planting, fertilization, cultivation , harvesting, storage, and processing for stock feed similar to those offered by cotton. Cooperation with the soild technologist and agronomist in establishing the seed bed, planting, fertilization, and cultivation requirements of corn in different soils and the development of methods and tools which will meet these requirements satisfactorily with a minimum cost for power and labor constitute proper activities for agricultural engineers. Cooperation with livestock and dairy husbandry specialists in developing the mechanical processing of corn into silage and ground feed offers the engineers other opportunities for research. These problems certainly need more thorough solution in the southeastern states, with special reference to the requirements of the medium and smaller sized farms.

The harvesting of corn is a time and labor consuming hand operation, and considerable progress has been made in the Corn Belt and elsewhere in

the development of mechanical methods of corn picking. The problem offered in the Southeast is perhaps not so much one of new methods and machines as it is one of adaptation or redevelopment of those available to economically meet the requirements of the medium and small sized farms for corn harvesting.

Other field crops such as potatoes, cane, tobacco, rice, and the like offer similar problems of planting, tillage, fertilization, insect control, harvesting, and storage. Cane cultivation, for example, especially under lowland conditions where ditching between rows is necessary to carry off seepage water, presents a challenge to the ingenuity of the agricultural engineer. In several localities of the Southeast and in Louisiana in the Middle South, none of the tillage tools available has been found economically adaptable to the cultivation of cane under such conditions. The necessity for considerable development and specific improvement for this purpose is evident.

Hay Crops.--In parts of the Southeast the loss of hay crops through inclement weather is frequent and serious. Under such circumstances natural methods of hay harvesting and curing become of uncertain utility. Furthermore, where considerable dairy and other livestock are fed such forage, it is of great economic importance that the forage be of uniformly high quality.

The artificial curing of hay crops, therefore, is being recognized as a necessity to the production of quality forage in humid regions where dairy and other livestock are fed. The Louisiana Experiment Station in the Middle South, for example, has developed the process and necessary equipment to a considerable degree. The Mississippi and Alabama Experiment Stations have undertaken similar studies of an even more fundamental nature. These call for cooperation with the plant physiologist and agronomist to elucidate the fundamental mechanism of moisture removal from and curing of hays of different types, and to determine how this mechanism may be controlled by artificial means. They also call for cooperation with the animal nutrition specialist to establish the requirements for and insure quality in the cured product. Thus an opportunity is offered the agricultural engineers throughout the Southeast to aid in the production of high grade forage for dairy and other stock.

Fruit crops.-- Practically every agricultural experiment station in the Southeast is conducting an extensive program of research in pomology, plant physiology, plant pathology, and entomology, aimed at the economical production of high grade fruit crops. Studies of orchard management and of the place of a fruit orchard in a diversified system of medium or small scale farming are numerous, primiary consideration being given to the power and labor items involved in planting, pruning, fertilization, spraying, picking, storage, packing, and transportation. In the citrus belt also the problem of adequate frost protection is ever present and offers an opportunity of unusual economic importance for engineering attention.

The pathological and entomological studies which are aimed at the control of fruit diseases and insects injurious to fruit trees and crops offer an especially wide field for profitable engineering investigations. The

tendency among entomologists, for example, now is to elucidate the fundamental relation between the physical properties of the surfaces of the vital organs of insects and those of the surfaces of certain insecticides. The idea is to develop the physical properties of the insecticides so that when properly applied they will stick and spread on the vital surfaces of insects and produce a maximum kill. Also, pathologists and especially entomologists are finding that many important pests can be attacked and killed most easily and economically at certain times and places.

The proper projection and deposition of dusts and sprays call for the development of methods and mechanical equipment which will specifically meet the requirements for the destruction of individual insects and diseases. This studies are necessary of the physics of these materials under pressure and the development of the mechanical principles of the apparatus required for projecting and depositing them where they will do the most good. Such research calls for the coordination of the highest type of engineering skill with that of horticulturists, entomologists, pathologists, and chemists in the identification and proper manipulation of the important physical and mechanical principles involved.

Truck crops.--Practically every state in the Southeast produces truck crops, especially tomatoes, sweet corn, beans, peas, sweetpotatoes and other root crops, and melons and cucumbers. Truck growing ranges from rather specialized operations on a large scale to average or small-scale gardening as a feature of diversified farming.

The problems of seed bed preparation, fertilization, planting, cultivation, spraying and dusting for insect and disease control, and harvesting are in general similar to those of field crop production, especially potatoes. They offer the same excellent opportunities for profitable engineering participation, and suggest the additional possibility, for example, of developing and adapting small unit, general-purpose labor-saving machinery for tillage, fertilization, planting, and cultivation, especially for medium sized trucking operations.

The diseases and insect pests of truck crops are numerous and varied, and many types and kinds of treatment used in their control involve special engineering features of spraying, dusting, heat application and the like. The bean jassid in Florida, the belted bean beetle in Alabama, the bean leaf beetle and Mexican bean beetle in South Carolina, the cucumber pickle worm in Tennessee, the harlequin bug in North Carolina, and other economically important insect pests are being studied by the entomologists of the region, and are being found in many cases to require some kind of mechanically applied treatment. The engineering problems offered are almost self-evident.

Crop storage.--The storage problems in the fruit and truck crop industries are quite general throughout the region, and appear to have many phases which yet remain unsolved. Physiological chemists and pathologists seem to have established that apples, peaches, and other fruits usually can not be stored with other crops without some loss. It is also known that certain rather definite temperatures and conditions of humidity are desirable for different varieties of fruits and truck crops, and that certain storage

conditions are favorable and others are unfavorable to some of the important storage diseases of different fruits and vegetables. The North Carolina Experiment Station, for example, has been especially interested in the feature with reference to the storage of sweetpotatoes. There is also considerable evidence available in some quarters which points to the fact that some types of storage lower the nutritive quality of certain fruits and vegetables, while other types of storage cause them to deteriorate generally in quality. The sweetpotato, for example, is one of the important truck crops in the Southeast which offers a difficult problem of curing and storage, while peaches, apples, pears, citrus fruits, and small fruits all introduce storage difficulties in which agricultural engineers should be interested.

An interesting and important feature is involved in the development of cold storage to prolong the salable life of some perishable fruits and vegetables and in defining the limitations for their profitable adaptation. The development of processes for economically freezing fruits, such as strawberries, peaches, figs, and the like, at extremely low temperatures to produce a more salable product also offers an extremely interesting engineering problem. Such work happens to be in progress at the Georgia Experiment Station.

The considerable amount of research of this general character in progress at the experiment stations in the region is establishing the bases upon which agricultural engineers can proceed to develop the desired storage structures and equipment. Close cooperation by the engineers with the truck crop specialists, pomologists, pathologists, physiologists, and nutrition chemists concerned would seem to be of the utmost importance in attacking these problems.

Soil erosion.--Soil erosion always has been a problem in the crop production of the southeastern states, and some work of an outstanding character has been done, notably by the North Carolina Experiment Station in cooperation with the U. S. Department of Agriculture. The Alabama Experiment Station has undertaken a controlled fundamental study of the important mechanical, physical, and physicochemical factors involved in the erosion of different important agricultural soils under the influence of run-off water. This research calls for both plat and laboratory studies and is aimed at the development of the basic principles governing the design of erosion prevention equipment. Naturally a knowledge of crop and soil technology is desirable in such work, and this usually can be secured best by cooperation with specialists in these lines. The fact that the U. S. Department of Agriculture is entering into a study of soil erosion and run-off prevention on a regional and national basis is evidence of the economic importance of the problem to agriculture. It offers the agricultural engineers of the southeastern states a real opportunity to participate in worth while research.

CONCLUSION

The above brief review of the high points of the agricultural research active in the southeastern states, while obviously incomplete, nevertheless indicates some of the outstanding opportunities for agricultural engineers to participate therein in a definite and constructive manner. Many other opportunities which might have been discussed also exist in the structural and feed processing problems incident to animal, dairy, and poultry husbandry and in the mechanical equipment problems of dairy production and manufacture. However, the above brief recital of some of the engineering problems incident to the production of the more important crops of the region would appear sufficient to indicate that it is not particularly necessary or desirable for agricultural engineers to look much beyond the programs of research existing in their own experiment stations to find ample opportunities for profitable research undertakings.

The nature of most of the opportunities for research noted also emphasizes the fact that constructive participation by agricultural engineers in much of the agricultural research of the region calls for a knowledge of and ability to use advanced physics, mechanics, thermodynamics, kinematics, electricity, and the like. Advanced training in these subjects seems desirable for research workers in the agricultural engineering of the region.